The EMMA Lattice

Lattice Geometry

The positions of magnets and cavities will be described with respect to a connected sequence of straight line segments. Three values will describe the position of any given element with respect to the line segment:

1. The distance along the line where you enter the element
2. The distance along the line where you exit the element, or equivalently the length of the line segment that the element occupies
3. The horizontal displacement of the element center with respect to the line segment

For EMMA, the geometric description simply consists of 42 identical straight line segments of length 394.481 mm. Each straight line segment is divided into four sections, in the following order:

Long drift	210.000 mm
F quad	58.782 mm
Short drift	50.000 mm
D quad	75.699 mm

Within the long drift, if there is a cavity, it will occupy the central 105.000 mm.

Individual Lattice Parameters

Once the geometry has been specified, the lattice will be completely specified by giving the gradients in the quadrupoles and the horizontal displacement of the quadrupole centers with respect to the line segment. The quadrupole fields are assumed to be constant along the quadrupole length, given above, with an additional "hard-edge" map at the entrance and exit. All lattices are designed to accelerate from 10 MeV kinetic energy to 20 MeV kinetic energy. The lattices are

- The baseline lattice
- The medium tune lattice
- The low tune lattice
- The high efficiency lattice
- The baseline lattice with the parabola minimum shifted to lower energy
- The baseline lattice with the parabola minimum shifted to higher energy
- The high efficiency lattice with the parabola minimum shifted to lower energy
- The high efficiency lattice with the parabola minimum shifted to higher energy

The parameters as output from the design code are in the .dat files in this directory. In the title of the HTML page above, the name of the correponding .dat file is given. For example, 070221b.dat is the file for the baseline lattice. Note that the basic geometric parameters are given only in that file. The meanings of the symbols in the .dat files are:

ld	Long drift length (m)

lq	Shoft drift length (m)
lqd	D quad length (m)
xd	D quad horizontal displacement (m)
b1d	D quad gradient (T/m)
lqf	F quad length (m)
xf	F quad horizontal displacement (m)
b1f	F quad gradient (T/m)

Required Parameter Ranges, Apertures, and Frequency Ranges

From the parameters for the individual lattices, one can determine the range of displacements and gradients for the magnets; they are:

	D	F
Baseline Shift	34.048 mm	7.514 mm
Minimum Shift	28.751 mm	4.903 mm
Maximum Shift	48.559 mm	10.212 mm
Baseline Gradient	-4.704 T/m	6.695 T/m
Maximum Gradient	-4.843 T/m	6.847 T/m

The pipe apertures are

	D	F	Cavity
Minimum horizontal	-7.416 mm	-21.638 mm	-16.936 mm
Maximum horizontal	18.789 mm	20.700 mm	17.814 mm
Half height	11.676 mm	8.906 mm	10.571 mm

One can derive some further aperture parameters from these:

Maximum horizontal in D magnet	-55.975 mm
Maximum horizontal in F magnet	-31.850 mm
Cavity center position	0.439 mm
Cavity aperture diameter	34.751 mm

Finally, the required frequency range (as deviations from 1.3 GHz) is:

Minimum frequency deviation	-4019 kHz
Maximum frequency deviation	1554 kHz

Lattice Parameters

This data file contains lattice parameters for the closed orbit as a function of kinetic energy. The columns are

1. Kinetic energy (eV)
2. Closed orbit horizontal position at the center of the long drift (m)
3. Closed orbit horizontal momentum at the center of the long drift (eV/c)
4. Time of flight for a single cell, relative to the time synchronized to 1.3 GHz RF (s)
5. Horizontal tune for a single cell
6. Vertical tune for a single cell

There are several sets of data, one for each lattice listed above, in the order listed above.

The most difficult part of reproducing these numbers comes from handling of the end fields. The precise method is described in this paper. The idea is to include the lowest order contribution from the ends as a single transformation at the entrance/exit of the magnet. I include the first two terms in the series in computing the generator, under the assumption that the quadrupole fields maintain a cos(2θ) symmetry (the expansion for that assumption is not shown in the paper). The Lie generator is evaluated using the implicit midpoint method as described in the paper.

Links to:

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